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Barriers to active participation of school-aged children

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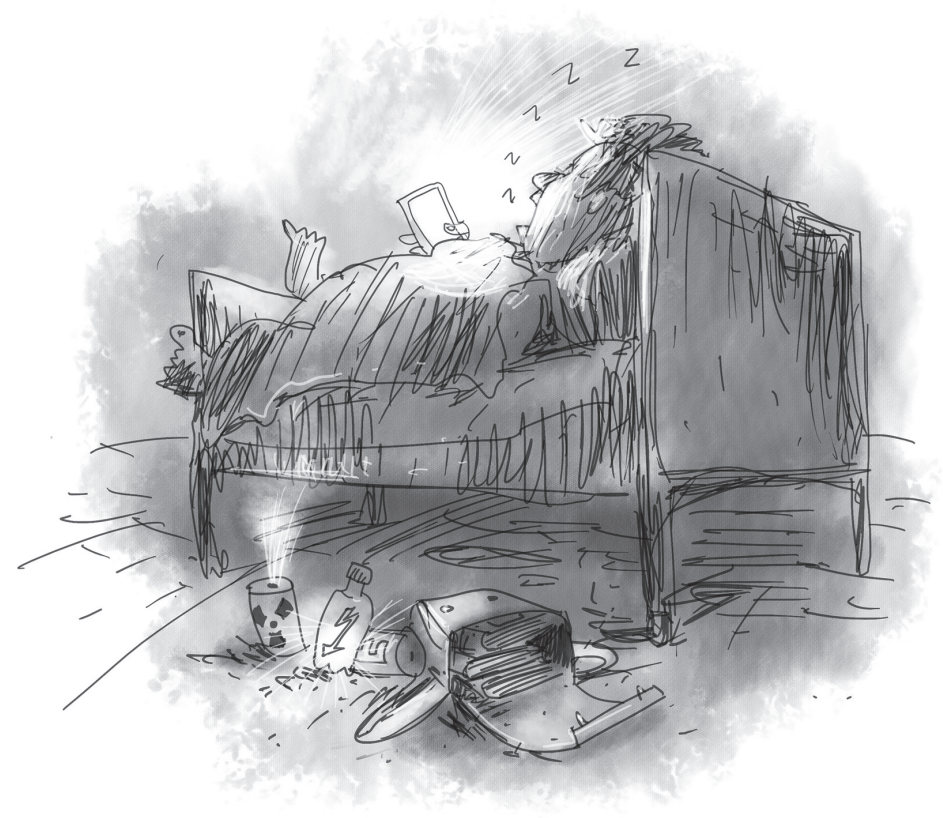
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were unable to confirm that involvement in PA moderates the association between high involvement in SB behaviour and health problems, our findings do not support the hypothesis on compensation for negative health consequences (Ferrar et al. 2013). This study has several important strengths, but it has also some limitations. The most important strength is the representativeness of our sample of adolescents and its comparability with existing international data within HBSC study. On the other hand, the main limitation is that only self-reported data were used. While self-reported data on psychological complaints are a rather preferred source of information, the validity and reliability of self-reported as well as measured PA or sedentary behaviour indicators have been heavily discussed in the literature (Bobakova et al. 2015; Biddle et al. 2012; Corder et al. 2009; Slootmaker et al. 2009; Baquet et al. 2007; Nilsson et al. 2002) and should also be taken into account in our study. Some studies indicate that self-reported tools were unable to accurately estimate time spent on an activity, but they may rank individuals accurately (Bobakova et al. 2014; Corder et al. 2009). On the other hand, the accuracy of the accelerometer is dependent on the type of activity and the adherence of the respondents to wearing the accelerometer properly. In addition, its usage requires financial means to purchase large numbers of accelerometers and the available time and manpower needed to process data from them (Slootmaker et al. 2009; Baquet et al. 2007; Nilsson et al. 2002). Neither the questionnaire nor the objective measurements, such as using an accelerometer or pedometer, is a gold standard for measuring PA or SB, and validation studies are needed to estimate possible bias. Another limitation is the cross-sectional design of this study, because of its inability to formulate conclusive statements about the causality of our results. Hume et al. (2011) indicated that symptoms of depression predict a higher level of TV watching, which suggest that SB activities and some of health complaints do not have to be in a one-way association, but it is not possible to explore this association in a cross-sectional study. The findings, therefore, need to be confirmed in longitudinal studies.

At the present time, adolescents all over the world are getting used to spending much more time in front of the TV or computer than in being engaged in PA, which seems to have negative consequences on their psychological and physical health. It seems important to decrease the amount of time which adolescents spend with SB activity and at the same time to promote PA. Parents could play an essential role in the reduction of time spent with SB activities and in the promotion of PA. They have an opportunity to restrict the time spent watching TV or playing on a PC through agreed family rules and at the same time to promote PA among their children through participation in an active lifestyle.

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Do sleeping and eating habits mediate the association between screen time and school difficulties?



Do sleeping and eating habits mediate the association between screen time and school difficulties?

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Submitted

Abstract

Background: This study examined the associations of Internet and computer screen time with school difficulties and the role of sleep quality and unhealthy eating habits.

Methods: We used data from the cross-sectional Health Behaviour in School-aged Children study collected in 2014 among Slovak adolescents (aged 11.0 to 15.9 years, N=7,595, 48.1% boys). We examined the inter-relations between time spent with a computer (time spent playing computer games or using the Internet), sleep quality (sleeping shortage, sleeping difficulties), unhealthy eating habits (consumption of soft and energy drinks) and school difficulties (low academic achievement, disliking school, being pressured by schoolwork and truancy) using structural equation modeling.

Results: Results showed that the more time adolescents spent with a computer during leisure time, the more school difficulties they had. This association was mediated by a higher consumption of soft or energy drinks and a lower quality of sleeping. The direct effect of time spent with a computer on school difficulties and its indirect effect via sleep quality were relatively small (-0.26 and -0.30 respectively, standardized solution) compared with the indirect effect of time spent with a computer via unhealthy eating habits and sleep quality (0.65, standardized solution).

Conclusions: Time spent with a computer is associated with school difficulties, with sleeping and eating habits playing a substantial role in this association.

Key words: screen-based behavior, sleeping patterns, eating habits, school difficulties, adolescence

Introduction

Electronic media have become a fully integrated part of the lives of children and adolescents and a very important factor in their everyday lives. According to the EU Kids Online project, European adolescents spend almost two hours a day online (Livingstone et al., 2011). Time spent online has been constantly growing during the last few years thanks to the widespread use of smartphones and mobile Internet (Skarupova et al., 2016). Adolescents are daily involved in a wide range of online activities, especially in online games and online communication tools like chat and social networking sites, which might also be associated with negative aspects, such as excessive or addictive Internet use (Blinka et al., 2015; Andreassen et al., 2012; van den Eijnden et al., 2008). From a health perspective the key criterion is whether such excessive use contributes to individual distress in a child's life. In the case of children or adolescents, such distress could be particularly visible in the form of problems at school.

Time spent with electronic media might influence school difficulties via deteriorating sleeping quality. Computer game play has been shown to have a significant impact on sleep patterns and consequent verbal memory performance (Dworak et al. 2007). Sleep laboratory study, by Wolfe et al. (2015), found that video gaming was associated with sustained attention, mediated by sleep duration. Similarly, a small study by Dimitriou et al. (2015) indicated that negative sleep patterns are related to decreased school performance. This association was affected by media use and caffeine drinks consumption before sleep. Screen time has been proven to be negatively associated with sleep patterns – either by displacing time for sleep (Punamäki et al., 2007), physiologically arousing the users through exciting content (Ivarsson et al., 2013), or by suppressing the level of the sleep hormone melatonin through prolonged exposure to screen light (Higuchi et al., 2005). Moreover, it has been found that the mere presence of electronic media in the bedroom of children can lead to decreased sleep time. Insufficient quality and quantity of sleep and overall sleepiness have been repeatedly shown as being associated with decreased school performance (Dewald et al., 2010; Wolfson & Carskadon, 2003).

Screen-based activities also have various effects on dietary habits, e.g. frequent screen-based behavior was associated with high sweetened beverages consumption (Olafsdottir et al., 2014; Gebremariam et al., 2013) and high-fat and high-sugar foods intake (Lissner et al., 2012). Recent research suggests that a high consumption of caffeinated sugar-containing drinks is related to physical complaints (headaches, stomach aches, sleeping problems, and low appetite) among children, and a stronger effect is observed for energy drinks compared with cola drinks (Kristjansson et al., 2014). Caffeine consumption may also be associated with psychological symptoms, for instance, anxiety or depression (Richards & Smith, 2015). In addition, children who daily consume soft drinks are more vulnerable

to suffering from nervousness and irritability. That may in turn result in aggressive behavior, such as bullying or physical fighting (Holubcikova et al., 2015), which has become a serious issue in schools.

In summary, associations have been found between screen-based activities, well-being, sleeping and eating habits and school performance (Dworak et al. 2007; Wolfe et al., 2014; Dimitriou et al., 2015; Punamäki et al., 2007; Ivarsson et al., 2013; Higuchi et al., 2005; Dewald et al., 2010; Wolfson & Carskadon, 2003; Olafsdottir et al., 2014; Gebremariam et al., 2013; Lissner et al., 2012). However, the mechanism behind school problems and the route to them via excessive screen time has still not been fully understood. We aimed to assess the associations of time spent with computer game play and use of the Internet for communication and entertainment with school difficulties, and whether these associations are related to decreased sleep quality and quantity and a higher consumption of drinks rich in caffeine and sugar.

Methods

Sample and procedure

We used data from the Health Behaviour in School-aged Children (HBSC) study conducted in 2014 in Slovakia. To obtain a representative sample, we used a two-step sampling. In the first step, 151 larger and smaller elementary schools located in rural as well as urban areas from all regions of Slovakia were asked to participate. These were randomly selected from a list of all eligible schools in Slovakia obtained from the Slovak Institute of Information and Prognosis for Education. In the end, 130 schools agreed to participate in our survey (response rate: 86.1%). In the second step, we obtained data from 10,179 adolescents from the 5th to the 9th grades (response rate: 78.8%). Non-responses were caused mainly by school absence due to illness or other reasons and the refusal of parents or adolescent to be involved in this study. Respondents younger than 11 years and older than 15.9 years (929 respondents) and respondents with missing responses were excluded (1655 respondents), leading to a final sample of 7,595 adolescents (mean age: 13.53; 48.1 % boys).

The study was approved by the Ethics Committee of the Medical Faculty at the P. J. Safarik University in Kosice (No: 9/2012). Parents were informed about the study via the school administration and could opt out if they disagreed with their child's participation. Participation in the study was fully voluntary and anonymous, with no explicit incentives provided for participation. Questionnaires were administered by trained research assistants in the absence of a teacher during regular class time.

Measures

Time spent with a computer regarded computer gaming and Internet use. Computer gaming was measured by asking: "How many hours a day,

in your free time, do you usually spend playing games on a computer, a gaming console, a tablet (like an iPad), a smartphone or other electronic devices (not including moving or fitness games)?” Responses could range from “None at all” to “9 hours per day” (Currie et al., 2014). Use of the Internet was measured by the question: “How many hours a day, in your free time, do you usually spend using electronic devices such as computers, tablets (like an iPad) or smartphones, for example, doing homework, e-mailing, tweeting, on facebook, chatting, surfing the Internet”.

Unhealthy eating habits regarded the consumption of soft and energy drinks. This was assessed by asking children two questions, e.g. how many times a week they usually drank coke or other soft drinks that contain sugar, as well as how many times a week they usually drank energy drinks, e.g. Red Bull. Possible responses were: never”, “less than once a week”, “once a week”, “2–4 days a week”, “5–6 days a week”, “once a day, every day”, “every day, more than once”.

Sleeping quality was measured by asking about the duration of sleep and sleeping difficulties. Length of sleep was calculated from adolescents’ reports of bedtimes and wake-up times on school days. Bedtimes were asked as follows: “When do you usually go to bed if the next morning is a school day?” Answers ranged in half-hour intervals from “at latest 9 pm” to “2 am or later”. Wake-up times were assessed with the question: “When do you usually wake-up on school mornings?” Response categories ranged from “5 am at the latest” to “8 am or later”, in half-hour intervals. We then calculated sleep duration using the following formula: 24 - bedtime + wake-up time (Nuutinen et al., 2014). Moreover, children were asked to indicate how frequently during the last 6 months they had difficulties in getting to sleep. Responses for frequency were on a 5-point scale: rarely or never, about every month, about every week, more than once a week, and about every day.

School difficulties regarded academic achievement, liking school and being pressured by the schoolwork and truancy; they were measured by four separate questions. Liking school was measured by an item asking children how they feel about school at the present, with 5 response categories ranging from “I like it a lot” to “I do not like it at all”. Children’s academic achievement was measured by the question: “In your opinion, what does your class teacher(s) think about your school performance compared to your classmates?” with the response alternatives: “very good”, “good”, “average”, “below average” (Currie et al., 2014). Perceived schoolwork pressure was measured by a single item on the global feeling of being pressured by the demands of schoolwork, including work at school and homework. Possible answers were: “Not at all”, “A little”, “Some” and “A lot”. Finally, children were asked if they had skipped school without a proper excuse for at least one whole day in the last 12 months. Answers ranged from “never” to “three or more times”.

Statistical analysis

First, we assessed the Pearson correlations between all variables. Then we used structural equation modeling (SEM) to analyze the direct and indirect effects of time spent with a computer, eating habits and sleeping quality on school difficulties. We constructed latent variables for these concepts as follows: time spent with a computer was estimated from working with a computer and playing computer games; eating habits from the consumption of energy and soft drinks; sleeping quality from sleeping difficulties and length of sleep; and finally school difficulties from liking school, academic achievement, being pressured by the schoolwork and truancy. Robust maximum likelihood was used for the estimates. Analyses were performed using LISREL software (Sörbom, 2001).

Results

Table 1 shows the correlations of the examined variables. The strongest correlation was found between computer games and use of the Internet ($r=0.43$), followed by the correlation between soft and energy drinks ($r=0.38$). A relatively weak correlation was found between duration of sleep and sleeping difficulties ($r=-0.14$) and between School difficulties variables, with the strongest correlation between liking school and academic achievement ($r=0.28$) and the weakest one between being pressured and truancy ($r=0.04$).

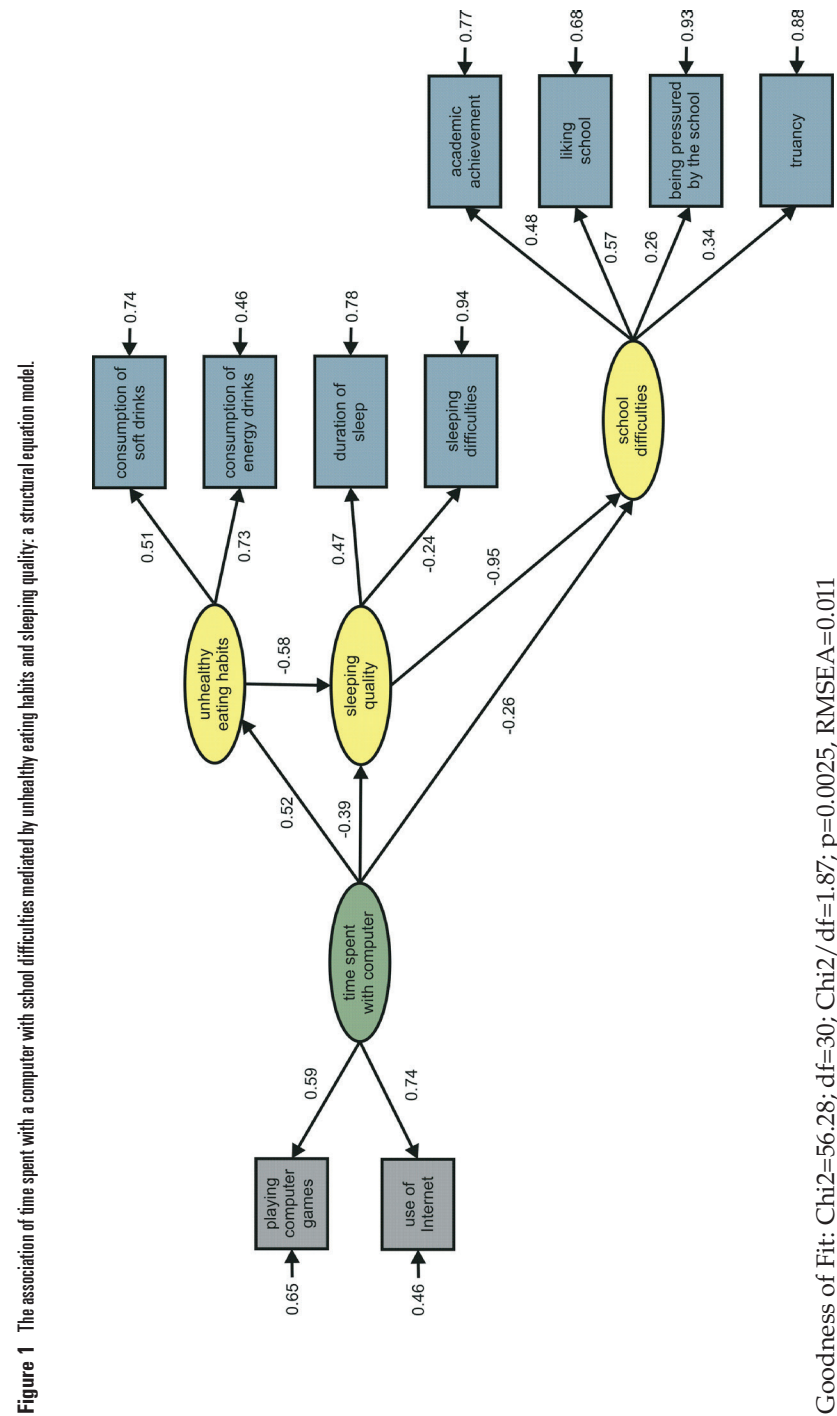
Table 1 Correlation matrix of variables (Pearson correlation coefficients)

	Time spent with a computer		Eating habits		Sleeping quality		School difficulties			
	Computer games	Use of the Internet	Soft drinks	Energy drinks	Duration of sleep	Sleeping difficulties	Academic achievement	Liking school	Being pressured	Truancy
Time spent with a computer										
Computer games										
Use of the Internet	0.43									
Eating habits										
Soft drinks	0.22	0.23								
Energy drinks	0.24	0.24	0.38							
Sleeping quality										
Duration of sleep	-0.15	-0.28	-0.16	-0.29						
Sleeping difficulties	0.06	0.10	0.06	0.12	-0.14					
School difficulties										
Academic achievement	0.12	0.12	0.16	0.23	-0.12	0.12				
Liking school	0.17	0.17	0.15	0.26	-0.19	0.11	0.28			
Being pressured	0.04	0.08	0.05	0.07	-0.07	0.15	0.14	0.19		
Truancy	0.05	0.12	0.10	0.21	-0.18	0.08	0.16	0.16	0.04	

Figure 1 describes the resulting structural equation model with four latent variables, each composed of several constituting variables. Time spent with a computer was associated with school difficulties directly, as well as indirectly via unhealthy eating habits and lower sleeping quality. The more time adolescents spent playing computer games or using the Internet, the higher the probability of their consumption of soft or energy drinks. Moreover, time spent with computer was associated with shorter duration of sleep and a higher prevalence of sleeping problems. Higher consumption of soft or energy drinks was also associated with lower quality of sleeping, and lower quality of sleeping was associated with more school difficulties, e.g. with a less positive attitude towards school, worse academic achievement and higher experienced pressure by schoolwork and truancy.

The standardized direct effect of time spent with a computer on school difficulties (-0.26), and the standardized indirect effect of time spent with a computer on school difficulties via sleeping quality (-0.30) were relatively low. However, the standardized indirect effect of time spent with a computer on sleep quality via unhealthy eating habits (0.65), as well as the standardized indirect effect of unhealthy eating habits on school difficulties via sleeping quality (0.55) was relatively high.

Acceptable values for goodness-of-fit indices were obtained ($\chi^2=56.28$; $df=30$; $\chi^2/df=1.87$; $p=0.0025$, $RMSEA=0.011$). The relations between the latent variables indicate high cohesion. The resulting regression parameters were relatively high; but the model explained a relatively small amount of the variability of the latent variables – the residual variances of endogenous variables were relatively high (>0.7). All regression weights were satisfactory (≥ 0.15).



Discussion

Time spent with a computer was associated with school difficulties directly and also indirectly via high consumption of soft and energy drinks and lower sleeping quality and quantity. The more time adolescents spent online, the higher their consumption of soft or energy drinks was. Higher consumption of soft or energy drinks was associated with lower quality of sleeping as well, and lower quality of sleeping was associated with more school difficulties, e.g. with a less positive attitude towards school, worse academic achievement, higher experienced pressure from schoolwork and truancy. The direct effect of time spent with a computer on school difficulties was relatively small in comparison with the indirect effect via unhealthy eating habits and sleeping difficulties.

Our study indicates a relatively weak direct association between time spent with a computer and school difficulties; such a direct association is assumed by the displacement hypothesis (Kraut et al., 1998). Some studies indicate that computer gaming and the mere presence of a computer in an adolescent's bedroom has a negative association with school performance (Gentile, 2009; Harris & Williams, 1985). Such findings are mostly explained by the displacement hypothesis stating that the time spent online is at the expense of time otherwise used for preparation for school or doing schoolwork. However, computers and the Internet may be used and often are used by children as an educational resource – for information, schoolwork, etc. (Kalmus et al., 2009). In line with this hypothesis, there are studies showing no or even a positive association of computer use with children's school results (Skoric et al., 2009; Borzekowski & Robinson, 2005; Sharif & Sargent, 2006). From this perspective the negative effect of media consumption on academic performance is mostly a matter of how such media are being used and not necessarily of how much they are being used. Some studies have shown that while excessive time with traditional media (television) is reflected in poor academic achievement, high time with new media (computer, Internet) does not (Borzekowski & Robinson, 2005; Sharif & Sargent, 2006).

Our model indicates that regarding adolescents' eating habits, the daily consumption of soft and energy drinks and impaired sleeping quality significantly contributed to the association between excessive time spent with a computer and school difficulties. Calamaro (2009) showed that the use of computers late into the night and subsequently consuming of beverages containing caffeine or sugar are related to the adolescent's ability to stay alert and fully functional throughout the day are the main components of energy drinks and partially also of soft drinks like caffeine, taurine, guarana and other stimulating ingredients, have a stimulation effect (Babu et al., 2008) and might disrupt the sleep (Temple, 2009). Moreover, high caffeine consumption during the previous evening

is positively associated with adolescents' daytime sleepiness the next day (Kristjansson et al., 2011). Problems with sleeping in terms of short sleep duration, daytime sleepiness or poor sleeping quality are frequent among adolescents (Gradisar et al., 2011); however, sleep seems to be crucial for them especially in the school context. One study suggests that sleep quality and quantity is closely related to children's learning capacity and learning-memory processes, which are important factors in school performance (Curcio et al., 2006).

The mediating role of sleeping quality and quantity has a crucial mediation role in the association between time spent with a computer and school difficulties. Our findings are in line with recent experimental (Wolfe et al., 2014) and diary-based (Dimitriou et al., 2015) studies suggesting that media use is negatively affecting cognitive and school performance only to the extent that it affects sleep.

On the basis of this we may tentatively expect that the more adolescents stay online later in the night, which thus limits their quantity of sleep, and the more they consume drinks that further worsen the quality of sleep, then this in turn causes school problems. However, the opposite causality is also possible. According to the mood modification hypothesis of media use, media entertainment is often used as tool for regulating stressful and otherwise unpleasant feelings (Reinecke et al., 2012). Adolescents may thus turn especially to media entertainment to regulate their school problems. And this may lead to a vicious circle: the higher time on the Internet may then cause lower sleep and further worsen school problems.

Strengths and limitations

This study's most important strength is the representativeness and large size of the sample of adolescents. Another one is the high response rate. However, some limitations need to be considered too. First, due to study's cross-sectional design, we are unable to further explore the direction of the relationships than we did with the application of SEM. Second, the relatively high proportion of explored variables variance was not covered by the latent variables. This can be due to other factors, besides the time spent on the computer contributing to school difficulties, problems with sleep or the consumption of energy and soft drinks. Nevertheless, the overall goodness-of-fit is acceptable. Finally, only self-reported data were used, which regard children's subjective perception of overall screen time. However, previous research supports the validity of self-reported measurement of screen-based behavior in adolescents (Leatherdale et al., 2014).

Conclusion

To conclude, the deteriorating effect of soft and energy drinks consumption on sleep quality seems to be strongly associated with school difficulties and to contribute most to the association between time spent with a computer and school difficulties. Therefore, the focus of health promotion strategies should be on maintaining healthy eating habits and sleeping habits. In other words, the possible benefits of using a computer or the Internet should not be at the cost of drinking soft or energy drinks, which leads to worse sleeping quality and school difficulties. Moreover, future research should also address the opposite pathway, i.e. whether school difficulties might contribute to excessive time spent with a computer. The resulting interventions may highly add to adolescents' health and to their future position on the labour market.